



**FCC Part 1 Subpart I  
FCC Part 2 Subpart J  
RSS 102 ISSUE 5**

**RF EXPOSURE REPORT**

**FOR**

**DUAL BAND RADIO MODULE**

**MODEL NUMBER: AXG-Y1**

**FCC ID: UFE-AXGY1  
IC: 6652A-AXGY1**

**REPORT NUMBER: R13179001-E6**

**ISSUE DATE: 2020-09-15**

**Prepared for  
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## REVISION HISTORY

| Ver. | Issue Date | Revisions                                                                  | Revised By      |
|------|------------|----------------------------------------------------------------------------|-----------------|
| 1    | 2020-07-24 | Initial Issue                                                              | Brian T. Kiewra |
| 2    | 2020-09-01 | Revised antenna gain to match OD and test reports.<br>Editorial revisions. | Brian T. Kiewra |
| 3    | 2020-09-15 | Revised antenna gain for External antenna.                                 | Brian T. Kiewra |
| 4    | 2020-10-23 | Removed tolerance note.                                                    | Brian T. Kiewra |

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## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** iRobot Corporation  
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**EUT DESCRIPTION:** Dual Band Radio Module

**MODEL:** AXGY1

| APPLICABLE STANDARDS                    |              |
|-----------------------------------------|--------------|
| STANDARD                                | TEST RESULTS |
| FCC PART 1 SUBPART I & PART 2 SUBPART J | Complies     |
| RSS 102 ISSUE 5                         | Complies     |

UL LLC. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

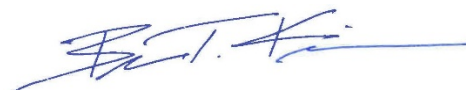
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Approved & Released  
For UL LLC By:



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Prepared By:



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Project Engineer  
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## **2. TEST METHODOLOGY**

All calculations were made in accordance with FCC Parts 1.1310, 2.1091, 2.1093, KDB 447498 D01 v06, KDB 447498 D03 V01, IEEE Std C95.1-2005, IEEE Std C95.3-2002, IC Safety Code 6 and RSS 102 Issue 5.

## **3. REFERENCES**

All measurements were made as documented in UL LLC Test Report R13179001-E1, -E2, -E3 for operation in the 2.4 GHz band and 13179001-E4 for operation in the 5GHz band.

Output power is excerpted from the applicable test reports.

Antenna gain data is excerpted from product documentation provided by the applicant.

## **4. FACILITIES AND ACCREDITATION**

The test sites and measurement facilities used to collect data are located at 12 Laboratory Dr., Research Triangle Park, NC 27709, USA and 2800 Perimeter Park Dr., Suite B, Morrisville, NC 27560, USA.

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0.

## 5. MAXIMUM PERMISSIBLE EXPOSURE (LIMITS AND EQUATIONS)

### 5.1. FCC RULES

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

**TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

| Frequency range (MHz)                                          | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm <sup>2</sup> ) | Averaging time (minutes) |
|----------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| <b>(A) Limits for Occupational/Controlled Exposure</b>         |                               |                               |                                     |                          |
| 0.3-3.0                                                        | 614                           | 1.63                          | *100                                | 6                        |
| 3.0-30                                                         | 1842/f                        | 4.89/f                        | *900/f <sup>2</sup>                 | 6                        |
| 30-300                                                         | 61.4                          | 0.163                         | 1.0                                 | 6                        |
| 300-1,500                                                      |                               |                               | f/300                               | 6                        |
| 1,500-100,000                                                  |                               |                               | 5                                   | 6                        |
| <b>(B) Limits for General Population/Uncontrolled Exposure</b> |                               |                               |                                     |                          |
| 0.3-1.34                                                       | 614                           | 1.63                          | *100                                | 30                       |
| 1.34-30                                                        | 824/f                         | 2.19/f                        | *180/f <sup>2</sup>                 | 30                       |
| 30-300                                                         | 27.5                          | 0.073                         | 0.2                                 | 30                       |
| 300-1,500                                                      |                               |                               | f/1500                              | 30                       |
| 1,500-100,000                                                  |                               |                               | 1.0                                 | 30                       |

f = frequency in MHz

\* = Plane-wave equivalent power density

#### **Notes:**

- (1) Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when a person is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
- (2) General population/uncontrolled exposure limits apply in situations in which the general public may be exposed, or in which persons who are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure

## 5.2. ISED RULES

For the purpose of this standard, Innovation, Science and Economic Development (ISED) has adopted the SAR and RF field strength limits established in Health Canada's RF exposure guideline, Safety Code 6.

**Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)**

| Frequency Range<br>(MHz) | Electric Field<br>(V/m rms)      | Magnetic Field<br>(A/m rms)                     | Power Density<br>(W/m <sup>2</sup> ) | Reference Period<br>(minutes)   |
|--------------------------|----------------------------------|-------------------------------------------------|--------------------------------------|---------------------------------|
| 0.003-10 <sup>21</sup>   | 83                               | 90                                              | -                                    | Instantaneous*                  |
| 0.1-10                   | -                                | 0.73/ <i>f</i>                                  | -                                    | 6**                             |
| 1.1-10                   | 87/ <i>f</i> <sup>0.5</sup>      | -                                               | -                                    | 6**                             |
| 10-20                    | 27.46                            | 0.0728                                          | -2                                   | 6                               |
| 20-48                    | 58.07/ <i>f</i> <sup>0.25</sup>  | 0.1540/ <i>f</i> <sup>0.25</sup>                | 8.944/ <i>f</i> <sup>0.5</sup>       | 6                               |
| 48-300                   | 22.06                            | 0.05852                                         | 1.291                                | 6                               |
| 300-6000                 | 3.142 <i>f</i> <sup>0.3417</sup> | 0.008335 <i>f</i> <sup>0.3417</sup>             | 0.02619 <i>f</i> <sup>0.6834</sup>   | 6                               |
| 6000-15000               | 61.4                             | 0.163                                           | 10                                   | 6                               |
| 15000-150000             | 61.4                             | 0.163                                           | 10                                   | 616000/ <i>f</i> <sup>1.2</sup> |
| 150000-300000            | 0.158 <i>f</i> <sup>0.5</sup>    | 4.21 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup> | 6.67 x 10 <sup>-5</sup> <i>f</i>     | 616000/ <i>f</i> <sup>1.2</sup> |

**Note:** *f* is frequency in MHz.

\* Based on nerve stimulation (NS).

\*\* Based on specific absorption rate (SAR).

### **5.3. EQUATIONS**

#### **POWER DENSITY**

Power density is given by:

$$S = \text{EIRP} / (4 * \text{Pi} * D^2)$$

Where

S = Power density in mW/cm<sup>2</sup>

EIRP = Equivalent Isotropic Radiated Power in mW

D = Separation distance in cm

Power density in units of mW/cm<sup>2</sup> is converted to units of W/m<sup>2</sup> by multiplying by 10.

#### **DISTANCE**

Distance is given by:

$$D = \text{SQRT} (\text{EIRP} / (4 * \text{Pi} * S))$$

Where

D = Separation distance in cm

EIRP = Equivalent Isotropic Radiated Power in mW

S = Power density in mW/cm<sup>2</sup>

#### **SOURCE-BASED DUTY CYCLE**

Where applicable (for example, multi-slot cell phone applications) a duty cycle factor may be applied.

$$\text{Source-based time-averaged EIRP} = (\text{DC} / 100) * \text{EIRP}$$

Where

DC = Duty Cycle in %, as applicable

EIRP = Equivalent Isotropic Radiated Power in W

#### **MIMO AND COLOCATED TRANSMITTERS (IDENTICAL LIMIT FOR ALL TRANSMITTERS)**

For multiple chain devices, and colocated transmitters operating simultaneously in frequency bands where the limit is identical, the total power density is calculated using the total EIRP obtained by summing the EIRP (in linear units) of each transmitter.

$$\text{Total EIRP} = (\text{EIRP1}) + (\text{EIRP2}) + \dots + (\text{EIRPn})$$

where

EIRPx = Source-based time-averaged EIRP of chain x or transmitter x

The total EIRP is then used to calculate the Power Density or the Distance as applicable.



## 6. RF EXPOSURE RESULTS

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

| External Antenna |                |                          |                        |                 |                |           |                          |                                     |                                    |
|------------------|----------------|--------------------------|------------------------|-----------------|----------------|-----------|--------------------------|-------------------------------------|------------------------------------|
| Band             | Mode           | Separation Distance (cm) | AVG Output Power (dBm) | Ant. Gain (dBi) | Duty Cycle (%) | EIRP (mW) | PD (mW/cm <sup>2</sup> ) | ISED PD Limit (mW/cm <sup>2</sup> ) | FCC PD Limit (mW/cm <sup>2</sup> ) |
| BLE              | GFSK - 500Kbps | 4.5                      | 0.53                   | 3.50            | 100.0          | 2.53      | 0.00994                  | 5.350                               | 1.00                               |
| BT               | GFSK           | 4.5                      | 11.71                  | 3.50            | 100.0          | 33.19     | 0.13049                  | 5.350                               | 1.00                               |
| 2.4GHz WLAN      | 802.11g        | 4.5                      | 19.07                  | 3.50            | 100.0          | 180.72    | 0.71053                  | 5.370                               | 1.00                               |
| 5GHz WLAN        | 802.11a        | 4.5                      | 16.76                  | 6.37            | 100.0          | 205.59    | 0.80832                  | 9.050                               | 1.00                               |

| PCB Antenna |                |                          |                        |                 |                |           |                          |                                     |                                    |
|-------------|----------------|--------------------------|------------------------|-----------------|----------------|-----------|--------------------------|-------------------------------------|------------------------------------|
| Band        | Mode           | Separation Distance (cm) | AVG Output Power (dBm) | Ant. Gain (dBi) | Duty Cycle (%) | EIRP (mW) | PD (mW/cm <sup>2</sup> ) | ISED PD Limit (mW/cm <sup>2</sup> ) | FCC PD Limit (mW/cm <sup>2</sup> ) |
| BLE         | GFSK - 125Kbps | 4.5                      | 3.82                   | 2.91            | 100.0          | 4.71      | 0.01850                  | 5.350                               | 1.00                               |
| BT          | GFSK           | 4.5                      | 13.01                  | 2.91            | 100.0          | 39.08     | 0.15367                  | 5.350                               | 1.00                               |
| 2.4GHz WLAN | 802.11g        | 4.5                      | 19.69                  | 2.91            | 100.0          | 181.97    | 0.71546                  | 5.370                               | 1.00                               |
| 5GHz WLAN   | 802.11a        | 4.5                      | 18.72                  | 4.31            | 100.0          | 200.91    | 0.78992                  | 9.050                               | 1.00                               |

### Notes:

- 1) The output power in the tables above is the maximum power among various channels, modes, modulations, and data rates within the specific band.

**END OF TEST REPORT**